The Marine Laboratory
UNIVERSITY OF MIAMI

INTERNATIONAL GAME FISH CONFERENCE

Miami Beach, Florida. November 19, 1958

held under the auspices of the

INTERNATIONAL
OCEANOGRAPHIC
FOUNDATION

and the

GULF AND CARIBBEAN FISHERIES INSTITUTE

CORAL GABLES, FLORIDA

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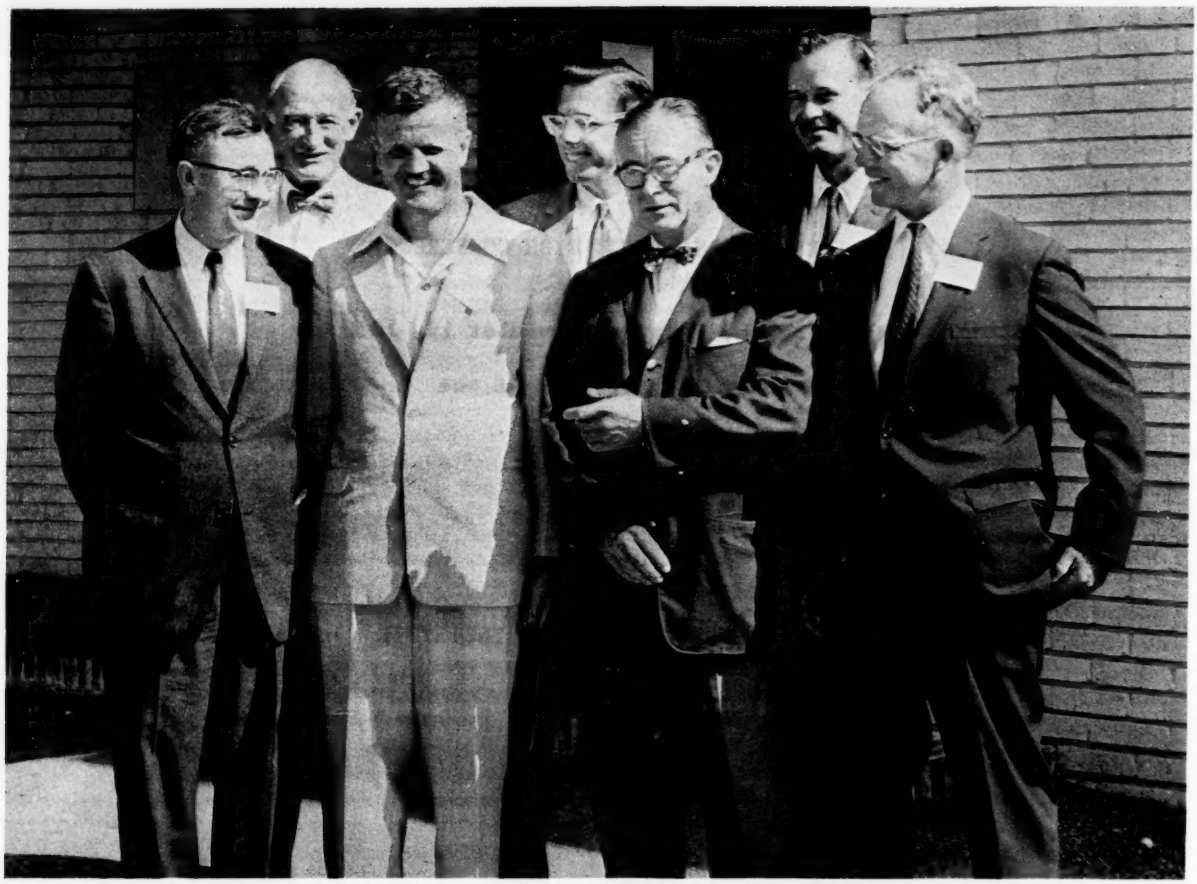
MORNING SESSION:
Chairman: Gilbert L. Voss

AFTERNOON SESSION:
Chairman: Louis A. Mowbray



Front row (left to right): Daniel H. Janzen, Director, Bureau of Sport Fisheries and Wildlife, Fish and Wildlife Service; Donald S. Erdman; F. G. Walton Smith, Director, The Marine Laboratory, University of Miami; and Frank J. Mather, III.

Back row: Col. John K. Howard; John E. Randall and C. Richard Robins.

CONTRIBUTION TO THE BIOLOGY OF THE TARPON (*MEGALOPS ATLANTICA*)

presented by

John E. Randall

THE MARINE LABORATORY
University of Miami

at the Third

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CONTRIBUTION TO THE BIOLOGY OF THE TARPON (MEGALOPS ATLANTICA)

John E. Randall
The Marine Laboratory, University of Miami

Research on the biology of the tarpon at the Marine Laboratory of the University of Miami has been supported by Mr. Roger Firestone, a member of The International Oceanographic Foundation, and the Florida State Board of Conservation. I was assigned to the project in September 1957. Shortly thereafter, a population of small juvenile tarpon was discovered on Lower Matecumbe Key in the Florida Keys by Walter Starck, a student at the University of Miami. Simpson (1954), in a short article recording two small tarpon found in Texas, stated that the life history of the tarpon presents an anomaly, namely the presence of comparatively large numbers of adults with only scarce and scattered records of the young. Thus the finding of a sizable population of juveniles was an exciting event. The pools in which the tarpon were located were nearly cut off from the sea. During periods of high water they were interconnected, and one of the group linked with the sea at very high tide. The largest pool was about 50 feet in greatest diameter, an average of two feet deep, and mud-bottomed. The water was brown in color and brackish (18 0/00 to 33 0/00 in the largest pond during September and October). Temperatures ranged as high as 36.6°C.

On September 4, Alan Moffett and I seined 59 tarpon from 33 to 166 mm. in fork length. Most were released where captured as were fish from successive collections in the same region. A length frequency plot of each collection at the different dates (September 8, September 12, September 20, September 28, October 12, and October 26) revealed a growth rate,by progression of one prominent mode, of about 10 mm. per week in September, dropping to about half this rate in October. Sixty-eight fish taken on November 9, 124 on November 23, and 36 on December 9, when plotted, showed that growth had slowed to less than half the figure for October. The decrease in growth correlated with decreasing temperature.

In October and November, Petersen disk tags were affixed to 89 of the little tarpon with monofilament nylon, the ends of which were melted with a flame into little knobs to keep the disks in place. Twenty-eight of the tagged fish were recovered. Their growth confirmed the estimates based on length frequency graphs.

Some of the little tarpon were kept for analysis of stomach contents and experiments on salinity and

temperature tolerance. The smaller juveniles (up to about 90 mm. fork length) proved to be plankton-feeders. They had strained tiny copepods of the genus Cyclops from the water. One 78 mm. fish had nearly 4,000 in its stomach. Fish larger than about 90 mm. began to show fewer copepods and more larger discrete items such as crab larvae and aquatic insects; still larger tarpon ate small fish.

Salinity experiments consisted of transferring the small fish from fresh water to sea water and vice versa with no mortality, quite an osmotic feat for any aquatic organism. The tarpon showed a considerable range of temperature tolerance. They survived in water from 19°C to 40°C (about 64°to 104°F). When kept in a cooler, shaded tank at the Marine Laboratory for two weeks, the little fish acclimatized and were able to survive 15° (55°F). Beginning December 11, Florida experienced its worst cold snap in years. Fishes were found dead in shallow waters throughout the state, among them, tarpon. After this spell only two small tarpon were found on Lower Matecumbe Key, where hundreds had been before.

This year we cannot count on a new crop of little tarpon in the same area, for bull dozers have been at work. And so it is probably the same story in many other comparable areas in the state. The extensive draining of brackish swamps and the filling of marshes and tidal ponds might well be reflected in later years in rather poor tarpon fishing.

I should add that more work is needed to more properly define the nursery grounds of the young tarpon. Previous literature records have been mostly from small, isolated, and not infrequently land-locked pools, some reeking of hydrogen sulfide. Whether such pools represent the primary environment or whether the tarpon are merely more readily seen and captured in such small bodies of water remains for more extensive surveys to reveal. One would think it would behoove the tarpon to seek out isolated pools on high tides, for it can survive in such waters, depleted in oxygen as they often must be, due to its ability to take air into its vascular, lung-like air bladder. In so doing, it would leave many predaceous fishes behind.

Thanks to a tip from Ed Corlett, a group of tarpon averaging about 30 cm. in fork length, was located in drainage ditches near Perrine in late August by Ed Iversen and Alan Moffett. Thirty from 24 to 39 cm. were seined and tagged with disk tags. On October 20, nineteen were caught, of which five bore tags and had grown 4 to 8 cm. On November 22, another effort was made to obtain fish; this time eleven were caught, of which three had been previously tagged. A 31.5 cm fish tagged on August 22 grew 5.2 cm. The other two (46.4 and 38.7 cm.) were tagged on October 20 and only grew 6 and 4 mm., respectively. The final collection on December 16 and 17 consisted of 36 dead fish found on the banks

of the ditches, all killed in the same freeze during which the Matecumbe tarpon had succumbed. The temperature in the ditches had dropped to 12.2°C (54°F).

The collection of data from the large adults is difficult. Little success has resulted from attempts to seine them. Since there is no commercial fishery for them, and since most sportsmen release tarpon after catching them, it is a big moment when a biologist gets his hands on just a few. Thanks to several taxidermists in southern Florida, such as Al Pfleuger, we were able to examine some during the fishing season Thirty-four large fish from the Keys taken from April 16 to July 2 were seen. Ripe male tarpon were first noted on April 23. No ripe or spent female fish were seen among the 34, however. From early May on, adult female fish displayed ovaries full of opaque eggs measuring about .7-.8 mm in diameter. No smaller ova other than the primordial stockpile were seen, suggesting that the tarpon spawns but once a season.

The most famous tarpon fishing site in Florida is Boca Grande Pass. In June, Moffett and I moved there. Our plan was to tag fish released by sportsmen and examine those few retained. We found about half of the tarpon which were caught to be running ripe males. The other half were hefty, but we never saw one with ova running, nor could any be squeezed from the fish. Among the fish taken for the purpose of mounting or for entry in the Sarasota tournament which we examined were 34 females. The first spent female which was seen was caught on July 11. Prior to this, 10 adult females caught from June 3 to July 10 all had ovaries filled with opaque eggs, just as the Key's fish did. From July 11 to August 19, seven spent females were detected among the 24 examined; two of these were caught off Venice, two off Clearwater, two off Sarasota, and only one from Boca Grande.

Of the spawning of tarpon, Babcock (1951) wrote, "The indications are that the time of spawning on the West Coast of Florida is from late June to September." Breder (1944) stated that tarpon spawn in West Florida "during May, June, and July, at least". Although my data are inadequate, they suggest that spawning occurred in July and August; however I hasten to point out that 1958 may not be a typical year. In view of the extraordinarily cold winter last year, gonad development may well have been retarded and the normal spawning season shifted a month or two later in the year.

Breder concluded that sexual maturity in tarpon is attained at a total length of about four feet and after passing their sixth or seventh winter (the age being determined by the reading of the scales). The largest sexually immature fish he saw was 127 cm. in fork length and the smallest ripe fish 125 cm. He did not state whether his fish were male or female, but I would presume female, for we observed more than a dozen ripe males less

than 120 cm., the smallest being 109.5 cm. The largest sexually immature female observed measured 122.5 cm. in fork length which is close to the size Breder cited.

One thing was apparent very soon after we began our tagging at Boca Grande. Male fish were consistently smaller than females. Nearly half of the fish taken were running ripe males. The remaining fish which were released could not be sexed, but judging from those we were able to cut open, nearly all of these were females. The question then arises whether the smaller males in company of the larger females are younger fish or whether they are fish of the same age and the females grow faster than the males. A quick analysis of the scales has revealed that the latter case obtains. The females appear to be about 15% larger than males the same age. Eight-year-old females seem to average about 148 cm. in fork length and eight-year-old males about 128 cm.

I should like to emphasize that our scale reading is preliminary. Not all of the scales have been read and more scales from female tarpon are needed. When tarpon were tagged, scales samples were taken from each fish and retained with data on the fish in a small envelope. When running ripe males were tagged, the sex was obvious and so recorded. We could not be certain, however, that all the other fish were females;indeed, a few suspected of being female merely because they were not shedding milt, turned out to be male fish.

The omnipresence of ripe males in the catch of sportfishermen during our six week stay in Boca Grande stood in sharp contrast to the complete absence of any female with ripe ova, or even ova in later stages of maturation. It had been hoped that a ripe female might be taken, and we could then attempt artificial fertilization of the eggs. We kept a bottle of milt on hand, renewing it as new ripe males were caught, in readiness for this possibility. Breder had entertained the same hope, but he never encountered a ripe female either. He concluded that the ripe female tarpon either do not take a bait or if they do they shed their row in the fight. I suspect the former is true. The spent female fish which I saw were obviously ones which had spawned and not just lost most of their ova fighting on hook and line, for only a very few residual ova were present. These were about 1.7 mm. in diameter.

Breder reported on another approach to obtaining mature, fertilizable ova of tarpon. A small enclosure was built near the shore at Boca Grande Pass and adult fish placed in it, in the anticipation that they would continue normal gonad development. The female tarpon responded by resorbing their eggs before they became ripe.

Tarpon are reported to spawn on beaches in relatively shallow water. If this is true, then it might be

possible to surround a school of spawning tarpon with a strong seine and thereby obtain ripe male and female fish.

In spite of much observation along the beaches of Gasparilla Island (on which Boca Grande is located) no schools of what would appear to be spawning tarpon were seen. On several occasions unsuccessful attempts were made to surround milling schools of large tarpon in 8 or 9 feet of water.

One other possibility exists to obtain the early stages in the life history of the fish. This consists of towing plankton nets inshore where schools of tarpon appear to be spawning. Breder did this and obtained ova which seemed the right size. He tried to rear them, but all died within 72 hours, at a stage too young to be certain they were tarpon. This was repeated by Marine Laboratory personnel a couple of years ago, but again the larvae all died. I believe, with care and persistence, tarpon larvae can be reared all the way to juvenile form as have the young of the related lady fish (Elops).

One hundred and eighty-five adult tarpon were tagged at Boca Grande in June and July of this year with yellow spaghetti tags. The tags are tubular vinyl plastic, reinforced in the center with 60 lb. test monofilament nylon. They were inserted through the back of the fish just behind the dorsal fin with a screwdriver, the end of which was sharpened and drilled with a hole the diameter of the tag. It was necessary to remove two of the large, tough scales from one side before passing the modified screwdriver through the back. As it was pressed through, two scales were forced off the other side. The four scales were saved. If a tagged tarpon is recovered, the original scale sample can be compared with new scales. This will be of importance in confirming the aging of tarpon by reading of the scales. The free ends of the tag were fastened together with a monel clamp on which is stamped a number.

All of the tarpon were obtained from sport-fishermen after being brought to the side of their boats. Before being tagged, each fish was anesthetized with a battery syringe of MS-222 (tricaine methanesulfanate) sprayed on the gills. A concentration of one gram to one liter of sea water was used. Approximately half a syringe of the solution was necessary to calm each fish.

Boca Grande Pass is well known for harboring sharks, which on occasions bite tarpon before they can be boated. A capsule of copper acetate was taped to the tag of every other tarpon, this capsule pierced before releasing the fish, in hopes of affording protection due to the alleged shark-repelling quality of this compound. One tagged tarpon was attacked and eaten by a hammerhead shark during daylight. This tarpon had no copper acetate.

A second tagged fish, however, had a capsule of repellent on its tag, and was taken by a shark within a minute of its release at night. Subsequently, most of the tarpon were transported to shallow water at the edge of the pass before being released, and no others were seen to fall prey to shark.

No recoveries have been made to date. Since the tags were placed on tarpon toward the end of the season, and little fishing is done in fall and winter months, the failure to recover any fish is not yet indicative of labor in vain. The number of fish tagged is small, and at best only a few recoveries can be expected. A 67.6 cm. tarpon tagged with a spaghetti tag in September, 1957 and released in the Miami Seaquarium is still holding its tag.

ASPECTS OF THE LIFE HISTORY OF THE GREAT BARRACUDA

Abstract

presented by

Donald P. de Sylva

Assistant Professor
Department of Biological Sciences and
Bayside Laboratory
University of Delaware

at the Third

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Abstract

The great barracuda, Sphyraena barracuda (Walbaum), is a percoid fish which differs from its nearest relatives, the silversides and mullets, by the presence of strong teeth. It occurs in all warm seas with the exception of the eastern Pacific. Although it is considered a coastal species, it may drift far from shoal water. Two other species are common in the western north Atlantic. These are guachancho and borealis. The status of the third species, picudilla, is uncertain.

Noticeable otogenetic changes occur in the eye diameter and head length, and in the length and position of the fins. These changes have caused much difficulty in identification. I have included 17 nominal species in the synonymy of S. barracuda, many of which are described on the basis of different growth stadia.

Age analyses were based on the scale readings and back-calculated lengths of 555 barracuda, and upon modes in the length-frequency distributions of over 2700 specimens from Florida. Scales show well-defined annuli which can be verified from length-frequencies and from examination of scales throughout the year. There is no significant difference in growth between the sexes. The barracuda reaches a length of about 6 feet and a weight of over 100 pounds. A 39-pound fish showed 14 annuli.

Most males mature at two years of age, and all mature at three. Some females mature at three years, and all mature at four. Off southern Florida, the spawning season is from April until October. Spawning was not observed, but probably occurs offshore, far from shoal water, since the postlarvae were taken in offshore surface waters over depths of 200 to 5200 meters.

The smaller barracuda occur inshore, where they feed upon gobies, cyprinodonts, atherinids and gerrids, and at a weight of about three pounds they move off to the coral-reef habitat and feed upon larger fishes. The most important groups eaten by adults are the Tetraodontiformes, or Plectognaths, parrotfishes, Beloniformes and jacks.

Other subjects which have been covered in this study include systematics, postlarval development, mortality, migrations, ecology, behavior, attacks on man, and poisoning by barracuda, or ciguatera.

The biology of most of the poisonous species is poorly known. The toxic nature of most of these species seems to be related to their habits, rather than to bacterial decomposition, or to the so-called endogenous theory, which holds that fishes merely become poisonous as a result of internal rhythms.

There is a great sea of paradoxes surrounding barracuda poisoning. For example, only those over three pounds are poisonous. Only one of two fish caught at the same time and in the same place is poisonous: Cuda caught in one part of an island or a reef may be safe, whereas those taken only a short distance away are poisonous to eat. Some species of Sphyraena such as guachancho, borealis, picudilla in the western north Atlantic and S. japonica, novae-hollandiae and pinguis in the Pacific are never poisonous, even though they occur in the same area as poisonous sphyraenids. Also, there is some seasonality in the distribution of barracuda poisoning, although this is not marked.

Fatalities from eating barracuda are rare, although nine instances have been reported in the literature, and at one time in the Marshalls there was an 8 to 10% mortality of those persons afflicted with barracuda poisoning.

In the Caribbean area, records of cuda poisoning date back several hundred years but only in the last few years have there been enough accompanying data to ascertain the nature of the poisonings. From 1954 to 1956 there were ten separate poisonings by freshly caught cuda which involved 57 persons in the southeastern Florida area.

A powerful alkaloid-like neurotoxin has recently been isolated by Hashimoto in Japan, but not identified, from the flesh of S. barracuda from the western Pacific, but this has not been done in the Caribbean region. There is no known method to identify a poisonous cuda other than by feeding it to animals first.

Although tetraodontid fishes are known to increase in toxicity during the spawning season, there is no evidence that the poisoning in cuda is directly due to a metabolic byproduct of their spawning season. Poisonings have occurred in Florida waters two months prior to the onset of the spawning season, and one month after spawning has ceased.

The greatest amount of evidence suggests that barracuda and other piscivores become poisonous as a result of their

food. Literature records indicate that from nearly all major groups of reef fishes and invertebrates, some have been implicated or have been suspected of being poisonous at one time or another, in spite of slight differences in the symptoms produced in humans. If we examine the interrelationship among the typical reef organisms, it is seen that certain of these groups show preferences toward definite kinds of food. It is known, for instance, that dinoflagellates and bluegreen algae are poisonous. It is relatively simple for these groups to be eaten by planktivorous clupeids which in turn could become poisonous, thence passing the poison on to the cuda, or to other predator teleosts. However, several paths of transmission may be followed from the basic plant material to the ultimate fish consumer as seen in this slide.

About 58% of the stomachs of adult barracuda contained fish groups which have caused poisoning in humans or have been suspected of being toxic; 20% of the total stomachs contained tetraodontiform fishes, which are well known for their toxic properties.

If we assume that cuda become poisonous as a result of their food and the food chain, it is possible to explain why only large cuda are poisonous. Note that the food of young, non-toxic barracuda differs essentially from that of adults. However, barracuda weighing more than three pounds move offshore to the coral reef habitat, where they feed upon the poisonous filefish, triggerfish, cowfish, parrotfish and puffer, or swellfish. These groups may occur in non-reef habitats, but they are not generally considered poisonous in these areas.

Small species of Sphyraena, such as borealis and guachancho, are not close associates of coral reefs, and do not feed upon coral fishes. Apparently these species never become poisonous.

It is known that the larger the cuda, the more severe will be the effects on the person ingesting the flesh. I believe that this is because that the larger cuda are able to take larger prey which they chop up with their sharp teeth and swallow. Presumably, the larger prey would contain more toxin in the flesh to be passed on to the predator.

The more or less seasonal variation in the toxicity of the barracuda can be explained by seasonal variation in the toxicity of the food. Tani and other Japanese workers have shown that tetraodontids are most toxic during the breeding season, and, conceivably, the toxin ingested by the cuda would depend on the spawning season of the prey.

In the tropical western Atlantic the marked geographic distribution of poisonous marine organisms seems to

relate to regions of high productivity in shallow, tropical seas. It appears that regions in which poisonous barracuda, and other toxic marine organisms occur, are characterized by steep-faced slopes and strong onshore currents. Conversely, localities where fishes are said to be never toxic have a gently sloping coastal shelf and weak currents. These factors may operate in two ways, (1) they may represent areas of phytoplankton convergence and concentration, and (2) they may be regions of high nutrient concentration which would favor the growth of phytoplankton and benthic algae. These plant forms would then be available to filter-feeding fishes and invertebrates, and to browsing benthic forms, which could be fed upon by barracuda or other large predators. Although this type of mechanism has not been actually demonstrated in salt water, it has been observed in freshwater by several Russian workers. Since such concentrations of phytoplankton and benthic algae are largely seasonal, perhaps the seasonality of poisonings could be related to variations in currents, winds, and nutrient supply.

Much field and laboratory work remains to be done, and it is hoped that persons working in poisonous regions will make every attempt to learn more about the subject of poisonous fishes.

MARLIN AND SAIL FISHING ON THE EAST COAST OF SOUTH AFRICA

presented by

John K. Howard

Research Associate
THE MARINE LABORATORY, UNIVERSITY OF MIAMI

at the Third

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MARLIN AND SAIL FISHING ON THE EAST COAST OF SOUTH AFRICA.

John K. Howard
Research Associate
The Marine Laboratory, University of Miami

HISTORY

The first marlin ever reported from South Africa was Gray's Tetrapturus herschelii from Table Bay in 1838. This is not really the East Coast of Africa, as it is on the Atlantic side of the Cape of Good Hope. Professor J. L. B. Smith (1956) said that he had no doubt that the origin of this fish was Indo-Pacific and not Atlantic, but Dr. J. E. Morrow has since examined the remains of this fish in the British Museum and there was enough of the pectoral girdle left to convince him that it was an Atlantic Blue Marlin. A paper will shortly appear on this in the Bulletin of Marine Science of the Gulf and Caribbean. The first marlin reported from the Southeast Coast of Africa was that reported in 1866 by Playfair from Zanzibar and named by him Histiophorus brevirostris, therefore mistakenly placing it in the Sailfish genus. It is interesting that Dr. Morrow has examined this fish in the British Museum and that it is a Black Marlin.

The first book known to me which might be said to deal with marlin, sailfish, and spearfish on the Southeast Coast of Africa, which considered them from an angling point of view, as distinguished from scientific descriptions, was Professor Smith's (1949) "The Sea Fishes of Southern Africa". He reports sailfish as having been taken by rod from the Natal shore. He does not speak of marlin being taken by anglers but does say that they had been taken by commercial fishermen on hand lines at or near the port of East London. Of the spearfish (Tetrapturus) he states that one was taken at East London, but it appears from the text and the scientific name used, that it may have been a marlin and this is confirmed by his 1956 paper.

This book was followed shortly by Hugh Copley's "The Game Fishes of Africa" (1952) which is truely an angler's book. Though this book includes the Natal Coast in the distribution of sailfish, it gives no information about them or their catches in South Africa. Of marlin, it is said that one specimen has been reported from Natal, but no further information is given.

The last publication which should be mentioned is Professor Smith's "Swordfish, Marlin and Sailfish in South and East Africa" (1956), referred to above. Though he does not accept as validly proven the difference between the Indo-Pacific Blue Marlin and the Black Marlin, he places the range of marlins from Kenya to the Cape of Good Hope and definitely identifies the Black Marlin

from the East Coast of South Africa. He also definitely identified the Striped Marlin from Mossel Bay on the same coast and from Mauritius. Striped Marlin were reported from sightings at close range, not captured, off Mombasa by Morrow (1954); both Black Marlin and Striped Marlin from Mauritius were identified by me from photographs shown me there in 1954. A specimen of Black Marlin taken off Durban by me in 1955, frozen and sent back to the United States, was identified by Professor Luis Rivas in 1955. There were no publications of the latter two identifications.

PRESENT STATUS

Through Dr. Morrow's and my work of last year (in publication by Dr. Morrow), we now know definitely that all three marlin, the Striped, Black, and Indo-Pacific Blue, exist in the Western Indian Ocean. A sufficient number of specimens of sailfish were collected to determine after study and analysis whether it is the same species as those of the Western Pacific. This work is being done by Dr. Morrow and will be published later.

The range of the sailfish in the Western Indian Ocean appears to be from Somalia to at least Durban in South Africa. Professor Smith (1956) reports finding the remains of a sailfish on the East African coast at about 32°S., just below Port Shepstone, south of Durban, but I have no records of any being caught south of the area immediately off Durban.

Professor Smith (1949) gives the southern limit of the marlins' range as the Cape and his 1956 paper reports the recent finding of a dead marlin floating in False Bay which is the bay just west of Cape Point, the southern extremity of the Cape of Good Hope. I have a report of a dead marlin found floating 30 miles south of Danger Point, about 60 or 70 miles east of Cape Point and of marlin being seen by commercial fishermen another 50 or so miles further east. But I have not been able to obtain any records of fish being caught by anglers or commercial fishermen west of Mossel Bay, about a couple of hundred miles further northeast.

At Mossel Bay in the summer of 1956 (January through March) 6 Black Marlin and 1 Striped Marlin were boated, several over 300 lbs. and one of 435 lbs., and many were hooked and lost. In February of 1957 a 720-pounder was taken, the South African record. Again, about 90 miles east off Plettenberg Bay, a tuna angler had a strike from a marlin which he saw plainly and commercial fishermen have reported seeing quite a number in this area. In 1954 a marlin was landed on rod and reel in Algoa Bay off Port Elizabeth. Again at least 3 marlin were caught there in 1956 and several were lost, all in the same summer season. This is the area from which Professor Smith reported catches by commercial fishermen (1949). About 150 miles northeast at East London in April of 1956 a 252 lb. marlin was caught; 4 others were hooked but lost.

This brings us to the Natal coast and Durban, about another 285 miles to the northeast. Both marlin and sailfish had been landed off and on before 1952, but the records are not very reliable. In Durban there is a group of very sporting anglers who fish from what are called skiboats. These are very small 14 or 16-foot outboard motorboats of which I will speak later. Primarily they fish for what they call "barracuta", Scomberomonus commersoni. This is the fish listed by Miss Francesca LaMonte in her "Game Fishes of the World" as the "tanguigue", Cybium commersonii. They fish with rods, reels, and bait. By chance they hook sailfish and marlin. Because of their boats and gear they lose many and rarely land a big marlin. In 1952 they boated 5 sailfish (one said to weigh 143 lbs.), in 1953, 2 sailfish and 3 marlin, and in 1954, 5 sailfish and 7 marlin, all between January and May, mostly in February. They were all small fish except one marlin weighing 181 lbs. and another marlin estimated at 300 lbs.

I fished out of Durban from January 9th through February 20th, 1955, a total of 42 days, of which we were able to fish only 11 full days, that is at least 7 hours. Fifteen days we were not able to fish at all, and the balance of 16 days we were able to get out from 1 to 6 hours before we were driven in by weather. This fishing was done from Mr. Ian Williams' "Merlin", a twin-engined 32-footer, and one of the most modern and best sportfishing boats in Durban. She was a comparatively good rough sea boat. I am told that this is not unusual weather for Durban and the East Coast of South Africa. On January 28th, our fifth full fishing day since January 9th when we started fishing, a marlin struck at about 11 o'clock in the morning. I hooked him but lost him on the third jump. Later that day at about 2 o'clock a very small marlin followed one of the baits for awhile, but did not strike. At first I thought it was a sailfish; its bill was so thin and small, but later I had a good view of its dorsal and it was a very small marlin. The following day at about 11:45 we raised a marlin; he struck, I hooked and boated him - 140 lbs. Just before this the rivers of all of this area went into flood because of terrific rains and at this time the sea for many miles offshore was dirty. We never found any good blue water again or any lines between the green and blue, though we went at least 12 to 15 miles offshore. The weather was little better so we were shorebound 6 days and were able to fish only 7 full days of the remaining 22, but we never raised another marlin or sailfish.

I have given this experience in some detail, as I am told that it is characteristic of the fishing off the East Coast of South Africa about as far north as Lourenco Marques.

That year mine was the only marlin caught. Two sailfish were taken by skiboats, both of which were given to me, were frozen and sent back to America. They were measured and studied by Professor Rivas and the data is now in our files.

In 1956 several sailfish and small marlin were caught by the skiboats, two of the marlins were shipped to Professor Smith and are included in his 1956 study. I do not have complete data as yet on the 1957 season, but some sailfish and marlin were taken.

Before I leave Natal and South Africa, the catches of marlin by commercial fishermen off the Pondoland coast, south of Durban, should be mentioned. Two Clarke brothers graduated from successful skiboat fishing to commercial fishing and took with them the use of rods and reels. They found that a crew could land many more fish, deep fishing, this way than with hand lines. When fishing the Pondoland coast, about 150 miles southwest of Durban, they frequently hooked marlin and landed some. This was deep fishing for a commercial fish, known as the "74" (Polysteganus undulosus) at about 40 to 60 fathoms. The marlin appear to take the 74's when they are being brought up. The Clarkes said that most of the marlin ran from 300 to 400 lbs. The season differs from that known for the other areas, being between May and November, with a peak in August.

SOUTH AFRICAN MARLIN AND SAIL FISHING GENERALLY

The skiboat fishermen have been mentioned above in connection with Durban. A skiboat is a small, 14 to 16-foot, boat completely covered over and watertight. There may be a small well or compartment in which to keep tools, engine spares, and gear. Otherwise, the interior of the hull is unavailable for use. They are powered by outboard motors, in Durban by law, two, though frequently one is high powered and the second is some small engine, such as a 2 h.p. Seagull, to cover the law and as a reserve in case of the main engine conking out. From 2 to 4 small, low fishing chairs are fixed on the top of the deck in various arrangements. The fishermen sit up in these chairs on the top of the boat. The reason for the development of these boats is that small boats are not allowed to use Durban Harbor. They are launched and landed from an open beach through the surf and moved about on land on trailers for storage, etc. Their main fishing grounds are not over 4 or 5 miles from shore and properly they rarely venture further off. They troll slowly or drift over their favorite grounds, the anglers using rather longish rods and one of them handling the outboard from one of the stern chairs.

This fishing brings up the question of harbors and the attitude of the Government towards boat fishing. My only experience was at Durban, but I was told that conditions were the same at the other fishing spots on the East Coast of South Africa. From my experience in 1955, which I was told was not abnormal, except for the heavy rains, floods, and consequent fouling of the sea to well off shore, there are evident difficulties. During the fishing season, say January through March, a great deal of stormy weather can be expected. On the long coastline from Mossel Bay to Durban, there are really only the ports of Mossel Bay, Port Elizabeth,

East London, and Durban which offer a proper haven for the typical, proper sportfishing boat, and the distances between these ports is great. Little or no cruising along this coast could be done, at least during the fishing season. A proper sportfishermen would be limited to a reasonable distance from the harbor where it was based. Another factor bearing on this picture is that the weather can change very rapidly and become dangerous very quickly, limiting the reasonable range of operation from the base harbor.

When I was in Durban in January and February of 1955, Mr. Ian Williams' "Merlin" was the only boat which approached the design and engineering of a proper sportfishermen (called "launch" by the South Africans). After we had rigged her with a fiberglass fighting chair, sent out from the United States, and bamboo outriggers which we made up locally, she was very useful for the purpose, though she had no flying bridge or half flying bridge with dual controls. There were other launches at Durban, but it would have been difficult to rig them for fishing and boating big fish.

I am told this is true of the launches at Mossel Bay and the other ports with the exception of Capetown, where there are some privately owned proper sportfishermen.

Why has there not been in South Africa more of a development of offshore angling? Some South Africans say because the fishing from shore is so good. I do not think this is the answer. My guess is that it is partly because South Africa is still to a certain degree a pioneer country so that its people have less leisure time for sport, partly on account of the weather and shelter conditions described above, and partly due to the Government's attitude.

I have mentioned the skiboat fishing at Durban where the boats are launched and landed through the surf on an open beach, not more than a couple of miles from a good harbor, which in most cases is nearer the fishermen's homes than the beach. This development has resulted from the Government's attitude towards such small power boats in Durban Harbor. The harbors of South Africa are run and controlled by what we would call a Federal agency, that is a central government agency, not an agency of the Provinces (state, we would call it). This agency is the South African Railways and Harbors Administration. From what I heard and saw in Durban in 1955 it seemed to me that this Administration had no interest in the development of offshore angling and gave no consideration to the possibility of developing it as a recreation for South Africans or an attraction for tourists. There was a Yacht Club, a launching ramp, and several piers, but the only road on which one must drive into the area was barred until 8 o'clock in the morning and after 5 o'clock in the evening. Except during these hours, one therefore had to carry one's heavy gear a

long way from the street down steps, through a tunnel, which appeared to be used as a latrine during the night, and up another flight of stairs and then a long way to the launch wharf. Hardly satisfactory. There were no facilities to obtain fuel, ice, etc. in the area. One had to go a long way up the harbor to obtain fuel. The comparison between these arrangements and facilities for launches and yachts and those in any of the smaller and less developed similar areas in the United States was marked. I was told that attempts to obtain a concession to provide fuel from one of the wharves had been refused by the Administration.

To sum up, in my opinion on the present evidence, the East Coast of South Africa is not a favorable place for sportfishermen to go to fish for marlin and sailfish.

LITERATURE CITED

Copley, Hugh
1952. The game fishes of Africa. H. F. & G. Witherby Ltd., London.

Gray, John E.
1838. Description of a new species of Tetrapturus from the Cape of Good Hope. Ann. Nat. Hist., 1(4):313.

Playfair, R. Lambert and Albert Gunther
1866. The fishes of Zanzibar. London.

Smith, J. L. B.
1949. The sea fishes of Southern Africa. Cent. News Agency, Ltd., South Africa.

1956. Swordfish, marlin and sailfish in South and East Africa. Ichth. Bull. No. 2, Dept. of Ichth., Rhodes In., Grahamstown, S. A.

A PRELIMINARY REVIEW OF THE AMBERJACKS, GENUS SERIOLA, OF THE WESTERN ATLANTIC

presented by

Frank J. Mather III

WOODS HOLE OCEANOGRAPHIC INSTITUTION
Woods Hole, Massachusetts

at the Third

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A PRELIMINARY REVIEW OF THE AMBERJACKS, GENUS SERIOLA, OF THE WESTERN ATLANTIC

Frank J. Mather III
Research Associate
Woods Hole Oceanographic Institution

INTRODUCTION

The genus Seriola belongs to the large and widespread group of carangid fishes which also includes the jacks (genus Caranx) and the pompanos (genus Trachinotus) as well as other genera. Several species of amberjacks have been recorded in the western Atlantic, and scientific workers still disagree over their nomenclature. I believe that it is fairly easy to separate the various species, once they have acquired their adult characteristics. There are difficulties, however, in determining the correct scientific names for the respective species. A major one arises from the inadequte original descriptions of several of the species and the apparent lack of type specimens for some of them. Moreover, few American workers have been able to examine the types or an adequate amount of material from the respective type localities. Furthermore the important changes in color pattern, in body and fin proportions, and even in counts, which the respective species undergo with growth, tend to make the study of the genus especially difficult. Therefore, for each species it is necessary to examine a series of specimens covering its complete size range. In comparing species, individuals of approximately the same size should be selected, and in dealing with early descriptions it is important to take into consideration the size of the specimens on which they were based.

In this study I have followed this procedure as closely as possible. Fortunately, measurements and counts for some of the type specimens, and other European and African material have been obtained through the kindness of Dr. Ernest A. Lachner of Washington and Dr. Emile Postel of Paris. I have examined a great deal of western Atlantic material in the field and have collected many specimens for laboratory study with the assistance of Woods Hole Oceanographic Institution personnel. Additional material has been examined in museums and University collections, or borrowed from them. Desirable specimens were taken during the recent Lou Marron - Woods Hole Oceanographic Institution expedition.

Most of the individuals down to about 6" in length have been caught on hook and line, but a few were taken in commercial fish traps. A few very small individuals were found in plankton collections but most of the small specimens were caught by dip netting. Two methods were used, one consisting of netting at night with the aid of a light to attract the fish when vessels were hove to or anchored and the other of netting clumps of sargassum weed from vessels while under way. These methods require but little equipment and might prove to be a fascinating extra activity for fishermen and yachtsmen.

The examination of about 140 specimens of Seriola involved the taking of about 40 measurements and the counting of gill rakers, fin rays and spines. Scales were also counted for a few individuals. In addition some 80 specimens were partially examined by taking only those measurements and counts which seemed to be of the most importance. Careful note was made of color patterns and of the extent of pigmentation and spination of the small individuals.

DESCRIPTION, IDENTIFICATION AND RANGE

There are at least 4 distinct species of Seriola in the western north Atlantic. To these I have tentatively assigned the names dumerili, rivoliana, fasciata and zonata. A fifth species which is known as the "horse-eye bonito" in Bermuda (and called dumerili by some workers) may be valid, but I have not been able to obtain enough information on it to confirm or deny this. Another species, which occurs in the western south Atlantic but apparently does not range north of Brazil, I have tentatively called lalandi.

The various species have several characteristics in common. The fin arrangement is somewhat similar to that of the bluefish. The first dorsal is small, with a short base, and is supported by 7 or 8 spines of which the 3rd to the 5th are the longest. In very small individuals, the last 2 spines are well developed and the web is continuous with that of the second dorsal. When the fish reach a length[1/] of about 2" or 3", however, the dorsal fins become separate and in most of the species, when the fish approach their maximum size, the posterior first dorsal spine often becomes overgrown, or nearly so. This fin can be retracted into a shallow groove, fitting perfectly with the dorsal profile. The second dorsal is not retractable and is higher, and its base much longer, varying from about 0.45 to 0.50 of the length of the fish. It consists of a short spine followed by from 27 to 40 soft rays. In small individuals, there is no marked peak at the anterior end of the fin, but the height of the fin decreases gradually to its posterior end. In the adults of some species, notably rivoliana, the second dorsal and anal fins develop distinct anterior peaks which become quite high in large individuals. In very small individuals, the last 2 rays are considerably shorter than the others and the posterior upper corner of the fin is rounded off, These rays soon grow to about the same size as those immediately preceeding them so that

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1/ The length measurement used in this paper, unless otherwise specified, is the "standard" or body length from the snout of the upper jaw to the end of the last vertebra. In large individuals it is easier to measure the "fork length" from snout to fork of tail. This is 7 per cent greater than standard length for dumerili, 8 per cent greater for zonata and lalandi, 10 per cent for rivoliana and 12 per cent for fasciata.

in individuals more than about 4" long this corner is sharp. The last second dorsal and anal rays, when laid along the body profile, reach to or very nearly to the pits where the anterior caudal rays emerge from the body.

The anal is generally similar to the second dorsal, but is smaller, its base being from 1/5 to 1/3 of the length of the fish. It consists of a small spine followed by from 17 to 22 soft rays. Two short stout spines precede the anal fin.[2/] In very small individuals these are well developed and are connected to the anal by a web, but with growth they soon become detached, and, in large individuals one or both are often overgrown. The pectoral is short, about 1/7 to 1/6 the length of the fish, and not falcate. It consists of a short spine and from 17 to 21 rays. The ventrals consist of a spine and 5 rays and are somewhat longer than the pectorals, notably so in small zonata. In small individuals the ventrals reach or nearly reach the vent and can be retracted into a distinct abdominal groove. With growth this groove becomes less prominent, and the distance from the ventral tips to the vent increases rapidly at sizes over 8" in all species except rivoliana, where it remains small (less than the diameter of the eye) except in large individuals. The caudal is well spread and deeply forked. In small individuals of Seriola the ends of the lobes are rounded but they become sharper with growth. The dorsal profile of the body is somewhat more curved than the ventral and the snout is conical but rather blunt. Small individuals are rather deep (depth 1/3 to 2/5 of length) and compressed (depth 2 to nearly 3 times width), but in most species depth diminishes with growth (to 0.23 of length in some species). As the width remains fairly constant in proportion to length they become less compressed (depth only a little over 1 1/2 times width in large dumerili and zonata) in the larger sizes. Adults of Seriola have distinct keels medially on the sides of their bodies just anterior to the caudal. These keels approach a wedge shape and are formed of flesh, without a cartilage-like development of the skin such as the tunas have, or greatly enlarged and specialized scales such as reinforce the keels of the jacks (Caranx) and some other carangids. The total number of developed gill rakers on the first arch in small Seriolas ranges from 16 to 28. Apparently the full complement of rakers is not always attained until the fish reach a length of about 2". With growth to larger sizes 1 or 2 more rakers at each end of the arch may be reabsorbed. This effect is not important in fasciata and is not marked except in very large specimens of rivoliana, but zonata and especially dumerili undergo an important loss of rakers, counts as low as 12 and 13 being common for large individuals.

The color pattern also varies greatly with size of fish. I have examined specimens less than 4/5" long of 2 species, dumerili and rivoliana, and one tentatively assigned to fasciata. These are not banded but are extensively spotted with dark cromatophores, and have a

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2/ Some authors consider these spines to be a part of the anal fin, but I have not done so in this study.

characteristic pattern of pigmentation on the second dorsal and anal fins. The 4 common species all show traces of banding at 4/5". The bands are fairly straight and solid when they first appear and vary in number from 5-6 for dumerili and rivoliani to 8 for fasciata. The bands of all except zonata become wavy and split as the fish grow. The bands extend into the web of the second dorsal and anal fins of 2 species (zonata and fasciata), but do not in others (dumerili and rivoliana). They disappear at sizes varying from about 7" for rivoliana and dumerili to about 10" to perhaps 13" for zonata. A nuchal bar from the eye to the dorsal profile (at the nape in fasciata and at the origin of the first dorsal in the others) persists after the bands disappear. This is usually darker and more prominent in small individuals and may become olivaceous or yellowish in larger ones. The colors vary considerably. Juveniles of dumerili and rivoliana have a yellow and light brown cast between the bands and especially on the fins and tail, but zonata is more black and steely while fasciata is more blackish, brownish, or olivaceous. Large specimens are usually silvery white below and darker on the back, often with lavender or golden tints, or both, along the sides. There is often a distinct amber or brownish band from eye to tail. The darker coloration may be olivaceous or brownish or dark steely blue. Large Seriola often have a purplish appearance when seen through clear water. Very small individuals have a long spine at the lower posterior corner of the preopercle, with a shorter one on either side of it. These disappear when the fish reach a length of about 1 1/2". Seriola in this size range also have a distinct brownish lump on either side of the dorsal profile above the posterior half of the orbit and extending somewhat further back.

S. fasciata, apparently the dwarf of the genus, is a pretty, little pumpkinseed-shaped fish. It is easily identified by its nuchal bar, which starts upward and backward from the eye but curves up sharply to meet the dorsal profile at the nape, well ahead of the first dorsal fin. The nuchal bars of all the others run straight back from the eye to the origin of the first dorsal fin. Another distinctive feature is the banding. There are usually 8 (occasionally 7) bands, which are split and wavy, and some of which extend into the webbing of the second dorsal and anal fins (except in individuals less than 1 1/2" long, whose bands may be solid and may not extend into the webbing, and those less than 3/5" long which probably have no bands). The largest fasciata examined (8" long) had distinct bands. It is possible that the species attains larger sizes and loses its bands, but the nuchal bar should still be diagnostic. The deep (depth about 0.39 of length) and compressed (depth nearly 3 times width) body also separates it from the other Seriola except perhaps small rivoliana, which have a much higher second dorsal lobe (about 0.21 of length in the smaller sizes, as against about 0.15 of length for fasciata). This species is seldom caught, or at least seldom recorded, perhaps due to its small size. A 8" fasciata when fresh appeared distinctly darker than several dumerili about the same size. The back was a brownish olive with steely and lavender pink reflections, the bars

brownish, the underparts a silvery gray, the caudal a yellow brown and the anal and second dorsal webs an olive grey, edged with yellow. The tip of the anal lobe was white and the last anal ray was clear whitish. In smaller preserved specimens the bands are dusky and the rest of the body is a steely grey or a yellowish brown, darker dorsally and lighter ventrally. Its range appears to include the coastal waters from the West Indies to Cape Hatteras and extends well out into oceanic waters, but it has not been recorded from the eastern Atlantic or the Pacific. I know of no common name for this species except the one proposed by Isaac Ginsburg, the "little amberjack".

S. zonata is readily identified in the smaller sizes (up to about 10") by its very bold and striking color pattern, with a distinct nuchal bar and 6 heavy, solid and regular black bands. A dark area at the base of the caudal may suggest a 7th band. The white tips of its caudal lobes are also diagnostic. In the larger sizes, the bands are lacking, but zonata may be distinguished from the others by the greater distance from its snout to the insertion of the anal fin, and the consequently shorter base of the anal fin. This is best utilized as a field character by comparing the base of the anal (exclusive of the detached spines) with the base of the second dorsal. For zonata, the second dorsal base is about twice (1.8-2.2) the anal base, while for the other species it is about 1 1/2 to 1 2/3 times the anal base. S. zonata is definitely more slender than rivoliana and fasciata, and somewhat more slender than dumerili in sizes over 12", but its depth in the 16" - 20" range is about the same as that of the south Atlantic species lalandi. The count of soft second dorsal rays separates zonata (33-40, usually 34-38) from fasciata (28-32) and, almost always, from rivoliana (27-33, usually 28-32), but it intergrades with those for dumerili (29-35, usually 31-33) and lalandi (32-34). Also, zonata and fasciata usually have 8 first dorsal spines, while the other species usually have only 7. It must be remembered, however, that in large individuals of the various species the last spine may be overgrown. In the banded phase, the nuchal bar and bands are solid black, the underparts are silvery, and the body between the bands is of a light brown or steely hue. A faint golden or bronze band often runs down the middle of the sides. I have not seen fresh individuals of the large unbanded form, but preserved ones are mostly brownish, varying from darker above to lighter below. S. zonata ranges from Brazil to Nova Scotia, being the only Seriola recorded from the Gulf of Maine, but it has not been recorded from the eastern Atlantic or the Pacific. It appears to be confined to coastal waters as we have never found it in our extensive offshore collecting efforts. This fish is commonly called the banded rudder fish, but, since it loses its bands at a size well below its maximum, Isaac Ginsburg has proposed the name "slender amberjack" for it. It reaches a size of about 21" and may sometimes be taken by sport fishermen.

S. rivoliana is readily separated from fasciata and zonata as described above. It is also easily separated from lalandi in the 16" - 24" range by its much greater depth (about 0.33 of length against about 0.23 of length for lalandi) and its much higher second

dorsal fin (about 0.26 of length against about 0.15 of length for lalandi). It can be separated from dumerili in the larger sizes by the same characters, although the difference in depth is not as marked (at 12", the depth of rivoliana is 3/8 of length, that of dumerili a bit less than 1/3 of length; at 24" the depths are about 0.30 and about 0.27 of length, respectively). There is also a great difference in total gill raker count between the species in the larger sizes (rivoliana 4" - 20" usually having 24-27 rakers, with those over 20" usually having only 21-24, while dumerili 4" - 20" have only 11-21 and those over 20" have only 11 - 14). In sizes below 4", rivoliana has 24 - 28 rakers and dumerili has 18 - 24, usually 19 - 22. Small rivoliana have a characteristic anterior profile which runs nearly straight from the origin of the 1st dorsal fin to the snout, while the profile of dumerili is more curved. The color patterns of the juveniles of the two species are very similar, but can be differentiated with practice. Both usually have 5 split and irregular vertical bands, with a dark area at the base of the caudal sometimes forming a 6th. The bars in rivoliana, however, are usually somewhat narrower and are more prominent than those of dumerili. The nuchal bar is especially prominent in rivoliana. In very small individuals of both species the bands are solid and those less than 3/4" long lack bands and can be separated only by the counts. The bands of both species fade out when the fish reach a length of about 7" but the nuchal bar persists. It is dusky or dusky brown in small rivoliana but becomes olivaceous with golden reflections in larger ones (over 12"). There are apparently several color variations of adult rivoliana which may depend somewhat on habitat. Some are predomonantly dusky or brownish, while others are more of a steely blue or olivaceous. Frequently the sides also show a lavender tint. There is considerable variation in the height of the second dorsal and anal lobes of this species. S. rivoliana attains a weight of at least 14 lbs. and perhaps grows much larger. It is of some interest to sport fishermen in the Bahamas and the West Indies and especially at Bermuda. The species is called the "bonito" in Bermuda and the "almaco jack" in the Bahamas. Isaac Ginsburg has proposed the name "falcate amberjack" for it. Its range probably extends over the Atlantic from Cape Hatteras (and northward to the offing of New Jersey) to Argentina and from the Cape of Good Hope into the Mediterranean. I have no knowledge of its occurrence in the Pacific.

I have been able to examine only 5 specimens of the species here called lalandi. Four of these were from Brazil, the type locality for the species, and one was from the Cape of Good Hope. These ranged from 18" - 23" in length. The body is more slender than that of dumerili (depth 0.23 of length for lalandi against 0.28 for dumerili 20" long), the head is shorter (0.27 of length for lalandi against 0.30 of length for dumerili), and the caudal peduncle (measured from the bases of the last second dorsal and anal rays to the caudal pits) is somewhat (0.073 of length for lalandi

against 0.067 of length for dumerili at 20") longer. The short head in fact separates lalandi from all the other Seriola discussed here, as the relative lengths of their heads are all about the same as that of dumerili. Superficially the specimens of lalandi were very similar to large zonata, but the head was shorter and the mouth notably smaller. Also the second dorsal ray count (32-34) and the size and location of the fins were more similar to dumerili. Gunther's catalogue describes this species unmistakably under the name of S. lalandi and gives its range as across the south Atlantic from Brazil to the Cape of Good Hope and through the Pacific to Japan. He calls it the "yellowtail" of St. Helena. The Brazilian specimens were too discolored to permit any dedutions about their original colors, but the one from the Cape of Good Hope was mostly silvery, with a lavender cast and a brownish back.

The remaining species of Seriola is the most important one to game fishermen, the common or great amberjack, which I have, along with Ginsburg and others, called S. dumerili. This species is very important to the charter boat fisheries of Florida and the Carolinas. Differences between the great amberjack and other western Atlantic species have been outlined above. In addition, the great amberjack attains a much greater size than any of the other local species. As far as I know, fasciata does not attain a weight of 1 lb. and zonata does not exceed 8 lbs. We have examined rivoliana up to 14 lbs. and they may reach a considerably larger size. The record "horse-eye bonito" taken at Bermuda weighed 54 lbs. S. dumerili is reported, as mentioned above, to reach 170 lbs. in the Mediterranean. For the western Atlantic, we have records of 125 lbs. from Florida and North Carolina, over 170 lbs. from Bermuda, and 177 lbs. from Trinidad. There is also a record of 120 lbs. from Rio de Janeiro, Brazil, but this fish may possibly have belonged to another species. S. dumerili ranges the American coasts from Cape Cod to Brazil, the western coast of Africa and the Mediterranean. There are amberjacks in the Pacific which are very similar to this species, if they do not belong to it. I have, however, not studied the Pacific forms sufficiently to express an opinion on their nomenclature. In color, dumerili follows much the same tendencies as rivoliana. The young have dusky or dark brown bands with a light brownish or olivaceous background between them. They are darker dorsally and silvery white ventrally, and generally washed with yellow tints. Several fresh caught individuals about 8" - 9" long were mostly yellowish, with the back olivaceous and the underpart silvery. Most of these had a distinct yellow band down the middle of the side. The fins and tails were mostly yellowish brown. One or two individuals, however, were a steely blue dorsally lightening to silvery white on the underparts. In these and larger individuals the nuchal bar was olivaceous washed with yellow. Large amberjacks are dark above, lighter along the sides with lavender and golden tints but sometimes with an amber band from eye to tail, and silvery white ventrally. The darker dorsal area may be brownish, olivaceous, or a dark steely blue. When seen alive in clear water they often took purplish.

The development of Mediterranean dumerili has been worked up by Sanzo. The juveniles shown are very similar to those of the western Atlantic form, which Sanzo accepted as synonymous with the Mediterranean one. Hildebrand and Cable studied the development of Seriola at Beaufort, North Carolina. Unfortunately, Hildebrand believed that dumerili was the only Seriola occurring in the western Atlantic, and 2 species, dumerili and fasciata, can be identified from the illustrations of the juveniles. It is therefore uncertain which species the larvae described belong to, although the probability is that they were of dumerili, the most abundant species in the area. The authors believed that the various amberjacks spawned off North Carolina from May to September. I do not know of any work on the spawning and development of the other species.

A tentative key to adult Seriolas and a summary of characters to help in identifying them at different sizes follows.

TENTATIVE KEY FOR SERIOLA MORE THAN 8" LONG

1. Depth about 0.38 of standard length at 8" - 12", diminishing to about 0.32 at 24"; more than 20 developed gill rakers (total count for first arch on one side). ----------2

   Depth about 0.33 of length at 8" - 12", diminishing to about 0.27 at 24" and 0.24 at 48", or less; less than 20 developed gill rakers. ----------3

2. Height[3/] of second dorsal at least 0.19 of length at 8" - 12", nuchal bar straight from eye to origin of first dorsal. Vertical bands on sides of body lacking (5 - 6 faint split bands not extending into webs of fins may rarely be found on individuals slightly over 8" long). ---------- rivoliana

   Height of second dorsal less than 0.18 of length. Nuchal bar curving from eye to nape at a point well ahead of first dorsal. Eight (rarely 7) split vertical bands, some extending into webs of second dorsal and anal fins present on 8" individual (no larger individuals have been examined; they may lack bands). ---------- fasciata

3. Base of anal fin about 0.50 of length of base of second dorsal. Individuals up to about 10" - 12" long with 6 distinct solid vertical bands, some extending into webs of second dorsal and anal fins. Depth about 0.25 of length in individuals 16" long. ---------- zonata

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3/ The height of the second dorsal is measured from its insertion (anterior intersection with dorsal profile) to the lip of its anterior lobe.

Base of anal fin about 0.62 of length of second dorsal. Vertical bands on sides of body lacking (5 - 6 faint split bands not extending into webs of second dorsal or anal fins may rarely be found in individuals slightly over 8" long). Depth about 0.32 of length at 16".---------- dumerili

Note: S. lalandi has been omitted from this key as it has not been recorded from the north Atlantic. Individuals 16" - 24" long have shorter heads than any of the other species (head about 0.27 of length, against about 0.30 or more for all the others in this size range). They are also more slender than most of the others at this size (depth about 0.23 of length, against about 0.27 or more for all the others except zonata). They differ from zonata in having a longer anal base (about 0.61 of the length of the base of the second dorsal for lalandi against about 0.50 for zonata).

SUMMARY OF CHARACTERS USEFUL FOR IDENTIFICATION OF SERIOLAS.

Color

Nuchal bar. Runs straight from eye to insertion of first dorsal fin in dumerili, rivoliana and zonata. Starts back from eye but curves sharply upward to nape well ahead of insertion of first dorsal in fasciata. Lacking in individuals less than 4/5" long and lacking or inconspicuous in lalandi 18" - 23" long.

Bands on sides of body. Present in dumerili, fasciata, and rivoliana 3/" to 6" - 8" long (possibly in larger fasciata), and in zonata 3/4" to about 10" long. In the first 3, the bands are split and irregular in all but the very smallest fish in this size range, but in zonata they are solid and more regular. The bands in dumerili and rivoliana do not extend into the webs of the second dorsal and anal fins, but in zonata and in fasciata (except the very smallest individuals), the bands which reach the bases of the respective fins extend into their webs. The bands usually number 8 for fasciata, 6 for zonata, and 5 - 6 for dumerili and rivoliana (the sixth band for the last 2 species, when present, usually consists mainly of dark areas around the caudal pits, especially the upper one).

Counts

First dorsal spines. These usually number 8 for fasciata and zonata and 7 for rivoliana and dumerili. In large individuals, however, the last spine may be overgrown or may not extend above sides of dorsal slot.

Soft rays of second dorsal. These number 30 - 34 (usually 31 - 33,

belief is that the western Atlantic form is the same as the Mediterranean one and that name rivoliana should therefore be applied to it. Consideration of the distribution of the species leads to the same conclusion. It is rather uncommon along our coasts, more common in the Bahamas, and very abundant around Bermuda. It is also very widely distributed on the high seas. Its juveniles are far more abundant than those of other Seriola in most offshore collections, and it is the only species which to my knowledge has been encountered in the adult form hundreds of miles from land. On occasion, small schools of them have gathered around research vessels which were hove to in oceanic waters. Thus it seems more likely that rivoliana has a trans-Atlantic distribution than that separate but very similar species exist on the eastern and western sides of the ocean. S. falcata appears to be a synonym, described as a different species because of the differences between large and small individuals. Likewise bonariensis (Cuvier and Valenciennes) appears to be a synonym of rivoliana based on a very small (3 1/2") individual.

The most important but also the most confused phase of the nomenclature of the genus Seriola is the question of the common or great amberjack. Several authors, including myself, feel that the western Atlantic form is the same as the Mediterranean one, whose name dumerili (Risso) has priority. Many other ichthyologists, however, believe that the American form differs significantly from the European one and that the name lalandi (Cuvier and Valenciennes) should be used for it. S. dumerili was well described from Mediterranean material, first by Risso, and then even more thoroughly by Cuvier and Valenciennes, who first described the genus Seriola. The type designated by the latter authors, which is 12" long, survives and has been examined for me, as noted above, by 2 experts. I have also examined 3 small Mediterranean dumerili and received measurements and counts from other Mediterranean and West African specimens from Dr. Postel. I have been able to find no important differences in proportions between the eastern and western forms, and only minor ones in counts. Again, however it would be desirable to examine more large eastern specimens. The reasons usually given for separating the American amberjack from the Mediterranean one are that the former attains a larger size, and that it is more slender than the latter. The first argument may be quickly eliminated. Risso's type description stated that some dumerili are caught weighing 175 lbs., and Cuvier and Valenciennes wrote that individuals of 160 lbs. were sometimes caught. The idea that the Mediterranean form was deeper than the American one probably arose from the fact that Cuvier's description was based on individuals only 13" (extreme length) long, which are relatively deeper than the larger individuals commonly caught in the United States. The depth measurements obtained as described above for European and African material, however, were not significantly greater than those obtained from western Atlantic material of the same size. Thus there appears to be no reason for a separation on the basis of depth. It may be objected that our great amberjack is essentially a coastal species and there-

fore cannot mingle with the European form. It has been established that the juveniles are widely distributed over the ocean, however, and some interchange between eastern and western Atlantic populations is therefore probable.

Most authors who have used the name dumerili for the American great amberjack have placed lalandi in its synonymy. An exception is Ginsburg, who put lalandi in the snonymy of zonata. I differ from both these views, believing that Gunther was correct in assigning this name to an entirely different species, the yellowtail of the south Atlantic. Unfortunately there appears to be no type specimen for lalandi. The original description of the species by Cuvier and Valenciennes, based on specimens 12" to 36" and more (total length) from Brazil, is meager. The chief differences noted between this species and dumerili were its more elongate body, and its more pronounced keels. The species here called lalandi certainly fills the first requirement. As noted above in the size range of the specimens examined (18" - 23" standard length), lalandi had a shorter head, a more slender body, and a slightly longer caudal peduncle than dumerili of the same size. All these factors contribute to a more elongate appearance of the body. The keels did not appear notably more pronounced than in dumerili of the same size. It must be recalled, however, that Cuvier's dumerili were only about 13" total length, at which size their keels are not conspicuous. I have not been able to examine lalandi of this size. Finally, Cuvier and Valenciennes found no nuchal bar on their specimens of lalandi, and this character was also lacking on those I examined.

Tentative List of Names for Atlantic Seriola

Common Name	Specific Name	Range (in Atlantic)
Great amberjack* Amberfish (Bermuda)	dumerili	Cape Cod - Brazil West Africa-Mediterranean (adults coastal, juveniles coastal & pelagic)
Almaco jack (Bahamas) Bonito (Bermuda) Falcate amberjack*	rivoliana	Cape Cod - Brazil West Africa-Mediterranean (coastal & pelagic)
Banded rudderfish Slender amberjack*	zonata	Nova Scotia - Brazil (coastal)
Little amberjack	fasciata	Cape Cod - Brazil (coastal & pelagic)
Yellowtail	lalandi	South Atlantic

*Preferred name

CURRENT STATUS OF THE MARLINS AND SPEARFISH

presented by

C. Richard Robins

THE MARINE LABORATORY
University of Miami

at the Third

INTERNATIONAL GAME FISH CONFERENCE

Miami Beach, Florida

November 19, 1958

CURRENT STATUS OF THE MARLINS AND SPEARFISH

By C. Richard Robins

The Marine Laboratory, University of Miami

Two years ago, at the First International Game Fish Conference, held at Nassau, it was decided to form a committee of ichthyologists interested in game fishes, especially the billfishes. This committee is truly international and has as its aim the dissemination of information. Thus, for the first time we are working, not independently, but with knowledge of the work of our colleagues. Duplication of effort is saved and the stability of both scientific and common names is slowly being worked out.

Increased interest shown by sportsmen has made possible the examination of many billfishes and has enabled scientists to study them on the spot in distant locations.

I have just returned from the Gulf of Panama where, with the cooperation of the Panama Marlin Club, and especially Mr. Frank Violette, I was able to examine a number of marlin. The results of this last trip are confusing and I must admit that I would have said a few weeks ago that the species of marlins were now identifiable and that the existing problems dealt with relationships of the species, integrity of populations, etc. The recent Panama trip suggests that at least one major problem exists in identification also.

First, let us review the overall billfish picture. We speak of sailfishes, spearfishes and marlins, of which the term spearfish is perhaps least known to you. Basically, they may be divided into two groups, as follows:- Group 1: 12 precaudal and 12 caudal vertebrae; bill proportionally longer in the young, becoming shorter with growth; dorsal fin high anteriorly and with the rest of the fin variously developed; flesh - "red meated"; size generally small, usually less than 200 lbs. Group 2: 11 precaudal and 13 caudal vertebrae; bill proportionally shorter in the young; dorsal fin rather low, its greatest height considerably less than the depth of the body; flesh-pale colored; size large, approaching 2,000 lbs.

To the first group may be assigned the sailfishes (Istiophorus), of which there are an uncertain number of species, the spearfishes (Tetrapturus), of which there are two and perhaps three species, and, in addition, two species generally termed "marlins": the white marlin of the Atlantic and the striped marlin of the Indo-Pacific. These two species are currently referred to the genus Tetrapturus by the present speaker.

It is with the blue marlins that the most confusion lies. The Atlantic blue marlin is known to all of you. Sportsmen recognized the existence of blue marlin in the Pacific and this fact has more recently been accepted by the scientist. Dr. Morrow has demonstrated differences in the bone structure of the pectoral girdle of the Pacific blue marlin when compared with the Atlantic blue marlin. I was unable to duplicate his findings a year ago in Panama, those fish that I examined being identical to the Atlantic fish. On my recent trip to Panama, I again saw blue marlin but they did not look the same. The lateral-line system differed, the bill was shorter and heavier and the fish was deeper anteriorly. I have not yet examined the pectoral girdles of these fish but the possibility exists of two species of blue marlin in the Pacific, one very similar or identical to the Atlantic species, the second, a distinct species. Panama fishermen have been convinced that they caught four species of marlin for some time. On the earlier trip, I had thought that the fourth species was probably a striped marlin but this idea was certainly wrong.

Miss Francesca LaMonte, who has recently returned from Hawaii, is of the same opinion after studying blue marlins there.

Naturally, these are but opinions, which may prove incorrect, but it does indicate that a major problem exists in the blue marlins.

Other problems exist. No one really knows what the original "spearfish", Tetrapturus belone of the Mediterranean is. Also, a juvenile billfish caught at Bermuda has a vertebral count of 13 precaudal and 11 caudal vertebrae. Since no variation within a species has been noted (and Japanese workers have examined many specimens), this specimen can not be identified with any known form. Counts and measurements taken in this specimen do not fit either the spearfish or the white marlin.

Thus, many problems still exist. Only with the continued cooperation of sports fishermen will these problems be answered in the near future.

FOODS OF PELAGIC FISHES FROM PUERTO RICO AND THE BAHAMA ISLANDS

Presented by

Donald S. Erdman

Fishery Biologist
Section of Fisheries and Wildlife,
Department of Agriculture and Commerce,
(Dingell-Johnson Program), Government of Puerto Rico

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ABSTRACT

This food habit study is based on the examination of the stomach contents of 200 pelagic fishes from Puerto Rico and 85 from the Bahama Islands. Eleven species of pelagic fishes which occur commonly throughout the Bahama Islands and the West Indies have been examined and are compared in this paper: blue marlin, white marlin, sailfish, yellowfin tuna, blackfin tuna, oceanic bonito, false albacore, wahoo, painted mackerel and barracuda.

The fishes examined were caught primarily by surface trolling by sportfishing boats; 24 fishes from Puerto Rico and 50 fishes from the Bahamas were caught by modified nylon floating long-lines, which fished to a depth of about 30 fathoms below the surface.

The most common food animal species found in most of these fishes was the filefish, Cantherines pullus. The pelagic young of shorefishes such as filefishes, triggerfishes, squirrelfishes, goatfishes, and doctorfishes were found to be a predominant factor in the foods of these pelagic fishes. Food animals include over 60 species of fishes and more than 10 invertebrates.

Since the future development of both commercial and sport fisheries in the Caribbean area may depend largely on the expansion of pelagic fisheries, especially tunas and marlins, any contributions to the knowledge of the biology and feeding habits of these fishes will be beneficial. Food habit studies in this paper are based on examinations by the author of over 700 stomach contents of pelagic fishes from Puerto Rico over a period of 4 years; this work constitutes part of the program work of the Dingell-Johnson Act in relation to sportfisheries in Puerto Rico. During April and May, 1958, the writer was a member of the Lou Marron - Woods Hole Oceanographic Institution "Pelagic Fish Research Expedition" through the Bahama Islands and vicinity. Mr. Frank J. Mather III, chief scientist of the expedition, was particularly interested in gathering data on the migratory routes of tunas. Food habit data collected from the stomachs of 85 pelagic fishes from the Bahamas are included in this paper.

Food habits of 11 species of pelagic fishes are discussed in respect to species of food animals involved, their comparative abundance, and indications of seasonal variation. Table I shows the

approximate number of fishes examined by species; "full" means stomachs that had one or more identifiable food animals, and "empty" means stomachs which were empty or had only slight unidentifiable remains of food.

The barracuda, though not usually considered a pelagic fish, is found on occasion many miles from land; it also feeds on bathypelagic fishes, and is included in this paper for these reasons. The painted mackerel is seldom found far offshore; it is chiefly a predator near coral reefs, but it is a good species to include for comparative purposes. The painted mackerel is ubiquitous in the Bahamas and the West Indies, the kingfish Scomberomorus cavalla also occurs though less commonly and their stomachs are usually empty, the spanish mackerel S. maculatus has not been seen by the writer in the West Indies and was seen in the Bahamas (boat captains around Bimini say that the Spanish mackerel is not found in the Bahamas).

Over 70 species of fishes and invertebrates have been found in the stomachs of these 11 fishes by the author. Table II lists the species of fishes and invertebrates and one black-colored petrel (bird) found in the fish stomachs.

The most important group of food fishes from the point of view of sheer numbers of individuals and frequency of occurrence are the solid jaw fishes, Plectognaths, such as the file fishes and triggerfishes. The most abundant food fish species is the filefish Cantherines pullus when it is in its pelagic stage from 1 to 2 inches.

From the point of view of total bulk and weight, the tunas (especially the frigate mackerel) are important foods of the blue marlin. Flyingfishes are the most important bulk food of dolphins.

Small squids around 2 inches in length appear to be the most abundant and frequent of the invertebrate foods. Crab "megalops" and stomatopod shrimps are abundant at times but their occurrence is more occasional.

Pelagic stages of young shorefishes seem to form the most abundant and frequent foods of these pelagic fishes. Filefishes and triggerfishes have been mentioned; goatfishes, squirrelfishes, doctorfishes, threadfins are other young shore fishes which are important as food items. The rarity of the pelagic young of groupers and snappers in the stomachs of these pelagic fishes is noteworthy.

Except for snake mackerels and black swallowers, deep-sea fishes are noticeably rare as stomach contents compared with shore fishes. Fishes caught by long-lines had a few more deep-sea animals than fishes caught at the surface, but the difference was slight.

The snake mackerels, Gempylus serpens, can be caught at surface at night over deep water with a trolling feather. It is possible that snake mackerels are preyed upon by larger fishes when they are near or at the surface at night.

What happens with the black swallower, Pseudoscopelus, is less clear. These fishes commonly gorge themselves on tiny fishes such as Bramids and Chaetodonts which are probably found near or at the surface. Black swallowers are not infrequently found in the stomachs of tunas and marlins from March through June off La Parguera; though they are usually pretty well digested themselves, the Bramids and Chaetodonts in their stomachs are well protected and are often in a good state of preservation.

The writer believes that black swallowers, usually 3 to 5 inches in length with large mouths and sharp fine teeth, are perhaps a key fish in the food chain of some pelagic fishes. The black swallowers themselves may be an indicator of the presence of marlins and tunas. The feeding of one barracuda on 5 swallowers is interesting. The barracuda was caught on a long-line set off South Caicos on May 15, 1958; the barracuda also had an adult mullet about 1 ft. long in its stomach (not a bait), which indicated perhaps that the barracuda had caught the mullet in shallow water and then proceeded to deep water where it caught the swallowers.

Table III shows probable seasonal distribution of food animals for blue marlins. Note that black swallowers have been found only during the first half of the year, in spite of the fact that most marlins examined have been caught in September and October.

Table IV shows the more important food items found in fish stomachs by species and by frequencies of occurrence.

The abundance of a very small red shrimp (about ¼ inch) stuffed in the stomach of an 11 lb. oceanic bonito caught off Christiansted, St. Croix, on May 2, 1957 is noteworthy because it shows that fair sized bonitos will feed directly off small plankton. Other bonitos in that same school, however, contained small filefishes in their stomachs.

The white marlin stomachs from Puerto Rico contained squids (in 4 marlins), snake mackerel (in 2), doctorfish (in 2), filefish (in 1), triggerfish (in 1), one blue runner, one young tuna, and one Brama. From the Bahama Islands, 5 white marlins had squids, 4 had Pseudoscopelus, 5 had snake mackerels; octopods, doctorfish, bigeyes, and round robins were only found once. It seems that squid play an important part as food of white marlins which is far less evident among blue marlins.

From sailfish stomachs in Puerto Rico, flyingfish have been found twice, halfbeaks twice, frigate mackerel 3 times, false albacore

twice, needlefish 4 times, squids 4 times, round robin once, blue runner once, filefish twice, triggerfish once, and bigeye once, and Uraspis heidi once. The presence of flyingfish and halfbeaks is an indication of different feeding habits from the marlins. The sailfish, like the dolphin, is probably better at quick turns and maneuvers.

Seasonal variation in food habits seems to occur among pelagic fishes probably depending more on availability than choice. Flying fishes are found in dolphins stomachs from October through June; they are most abundant in dolphin stomachs from February through March which is the time of greatest seasonal abundance of dolphins around Puerto Rico.

Young squirrelfish and goatfish are abundant in stomachs of oceanic bonitos in spring and again in the autumn which may in part be responsible for the large schools of bonitos which occur nearer the coasts during these times of the year.

Rate of digestion of food animals is rapid in pelagic fishes. Deep-sea fishes because of their soft bodies deteriorate even more rapidly than the young of shore fishes. Deep-sea fishes in the best state of preservation have been found in fishes caught early in the morning which indicates that they are preyed upon more at night. Pelagic young of shorefishes such as squirrelfish, goatfish, puffers, and triggerfish are eaten during daylight hours; they have actually been thrown up alive from the stomachs of recently boated tunas and bonitos. Dolphins have been caught during the day with flying fish in fresh condition. Crab "megalops" seem to be quite resistent and have been found in recognizable form in the intestines of oceanic bonitos where digested fishes were only macerated flesh and bones.

Cannibalism, which is common to many carnivorous fishes, occurs in pelagic fishes. Young dolphins have been found in dolphin stomachs, and young barracudas have been found in barracuda stomachs.

SUMMARY

The predominance of the pelagic forms of young reef and shore fishes among the food items of pelagic fishes is the most striking fact of this study, in the author's opinion. The lesser importance of deep-sea fishes has been noted. The relatively minor role of invertebrates as stomach contents, even including squids, is not explained and contrasts with published findings from the Pacific.

Other points of interest shown from this study are:

1. Flyingfishes are the chief bulk food of dolphins in winter.

2. The filefish, (Cantherines pullus), from 1 to 3 inches, is the most common food item.

3. Pseudoscopelus is a commonly occurring food in pelagic fishes.

4. Pelagic forms of young groupers and snappers are rarely found in stomachs.

5. Large blue marlins feed on 1½ inch transparent young doctorfish.

6. Deep-sea fishes are best preserved from fishes caught in early morning.

TABLE I

Number of stomachs examined of Eleven Pelagic Fishes from Puerto Rico and the Bahama Islands

Species	Puerto Rico		Bahama Islands	
	full	empty	full	empty
1. blue marlin *Makaira ampla*	48	51	3	1
2. white marlin *Makaira albida*	6	1	7	1
3. sailfish *Istiophorus americanus*	9	2	-	-
4. yellowfin tuna *Thunnus albacares*	12	-	23	-
5. blackfin tuna *Thunnus atlanticus*	20*	5*	3	2
6. oceanic vonito *Euthynnus pelamis*	20*	5*	1	-
7. false albacore *Euthynnus alletteratus*	20*	5*	-	6
8. wahoo *Acanthocybium solandri*	5*	20*	2	2
9. painted mackerel (cero) *Scomberomorus regalis*	15	30*	2	1
10. dolphin *Coryphaena hippurus*	258	32	20	2
11. barracuda *Sphyraena barracuda*	34	150*	1	8
	450**	250**	62	23

* numbers estimated
** numbers rounded

TABLE II

Food animals found in pelagic fish stomachs

	Scientific name	Common name	remarks
1.	Cantherines pullus	filefish	
2.	Monacanthus tuckeri	"	
3.	Alutera scripta	"	
4.	A. schoepfi	"	
5.	Xanthichthys ringens	triggerfish	
6.	Melichthys piceus	"	
7.	Lagocephalus sp.	smooth puffer	
8.	Diodon hystrix	porcupine fish	
9.	Lactophrys sp.	trunkfish	
10.	Priacanthus sp.	bigeye	
11.	Mulloidichthys martinicus?	goatfish	
12.	Holocentrus ascensionis	squirrelfish	
13.	Myripristis jacobus	"	in barracudas
14.	Ostichthys trachypomus	"	
15.	Aulostomus sp.	trumpetfish	2 in yellowfin tunas, 1 in barracuda
16.	Tylosurus sp.	needlefish	
17.	Ablennes hians	flat needlefish	
18.	Hemiramphus brasiliensis	halfbeak	
19.	Euleptorhamphus velox	flying halfbeak	from dolphins
20.	Cypselurus sp.	flyingfish	
21.	Cephalacanthus volitans	flying gurnard	
22.	Caranx crysos	blue runner	

TABLE II (continued)

	Scientific name	Common name	remarks
23.	Chloroscombrus chrysurus	bumper	
24.	Oligoplites saurus	leather jacket	
25.	Decapterus sp.	round robin	
26.	Selar crumenophthalmus	scad	
27.	Uraspis heidi		in sailfish
28.	Coryphaena hippurus	dolphin	in dolphins
29.	C. equiselis	pompano dolphin	in blue marlins
30.	Xiphias gladius	swordfish	in 2 dolphins, in 1 blue marlin
31.	Thunnus atlanticus	blackfin tuna	
32.	Euthynnus alletteratus	false albacore	
33.	E. pelamis	oceanic bonito	
34.	Auxis thazard	frigate mackerel	
35.	Psenes cyanophrys		common in dolphins in winter
36.	Nomeus gronovii	man o' war fish	1 from dolphin
37.	Epinephelus sp.	grouper	1 from oc. bonito, St. Croix
38.	Brama raii	sea pomfrets	from dolphins
39.	Teractes?	" "	from Pseudoscopelus stomachs
40.	Gempylus serpens	snake mackerel	
41.	Epinnula?		
42.	Pseudoscopelus sp.	black swallower	
43.	Myctophidae	lanternfishes	from yellowfin tunas
44.	Cyclothone ?	"	" " "

TABLE II (continued)

	Scientific name	Common name	remarks
45.	Sphyraena barracuda	barracuda	found in barracudas
46.	Mugil curema	mullet	" " "
47.	Jenkinsia lamprotaenia	sardine	" " " & painted mackerel
48.	Harengula sp.	"	" " " & found in barracudas
49.	Anchoa choerostoma	anchovy	found in barracudas & painted mackerel
50.	Gerridae	mojarras	found in barracudas
51.	Abudefduf marginatus	sergeant major	" " "
52.	Xenocongrid eels	eel	" " "
53.	Myrichthys oculatus	"	" " "
54.	Synodus intermedius	lizardfish	" " "
55.	Scarus croicensis	parrotfish	from barracudas
56.	Sparisoma radians	"	" "
57.	Haemulon sp.	grunt	" "
58.	Bathystoma aurolineatum	"	" "
59.	squids		
60.	octopus		
61.	Argonauta		from dolphins
62.	Portunus crabs		
63.	megalops stage	crab	
64.	Stomatopods	flat white shrimps	from dolphins & bonitos
65.	Squilla	mantis shrimps	
66.	Euphasids?	red small shrimps	from oceanic bonito, St. Croix

TABLE II (continued)

	Scientific name	Common name	remarks
67.	Polynemus virginicus	threadfins	from blackfin tunas, St. Lucia
68.	Ceratoidea	deep-sea angler	from white marlin
69.	Lutjanids?	small reddish spotted snapper-like fishes	from oceanic bonitos
70.	Clepticus parrae	wrasse	from patinted mackerel
71.	petrel (bird)		from blue marlin, South Caicos

TABLE III

Frequencies of occurrence of food animals by species and month* in the stomachs of 51 blue marlins (48 from Puerto Rico and 3 from the Bahama Islands)

Species	Feb.	Mar.	Apr.	May	June	July	Sept.	Oct.	Nov.	Dec.
frigate mackerel	-	1	1	-	-	-	5	6	-	1
blackfin tuna	1	1	1	-	-	-	2	4	-	-
oceanic bonito	-	-	-	2	-	-	-	-	-	-
false albacore	1	-	-	-	1	-	-	-	-	-
pompano dolphin	-	-	-	-	-	-	1	1	-	-
leatherjack	-	-	-	-	-	-	-	1	-	-
blue runner	-	-	-	-	-	-	-	3	-	-
round robin	1	1	1	-	-	-	2	-	-	-
bigeye	1	-	-	1	-	-	-	-	-	-
needlefish	-	-	1	-	1	-	3	1	-	-
triggerfish	2	-	-	-	-	-	1	4	-	-
filefish	-	1	-	1	-	-	1	-	-	-
puffer	-	1	-	1	-	-	-	-	-	-
doctorfish	-	1	-	-	-	-	-	-	-	1
butterflyfish	1	-	-	2	-	-	-	-	-	-
pomfret, *Brama*	1	-	-	2	1	-	-	-	-	-
swordfish	-	1	-	-	-	-	-	-	-	-
Pseudoscopelus	1	1	2	-	1	-	-	-	-	-
Snake mackerels	1	1	-	3	-	2	-	-	-	-
squids	1	2	1	1	-	-	-	2	-	1
octopods	1	-	-	-	-	-	-	1	-	-
petrel	-	-	-	1	-	-	-	-	-	-

*n records of full stomachs for Jan. or Aug.

TABLE IV

Frequencies of more important food animals by species found in pelagic fish stomachs

Species	yellow-fin tuna	black-fin tuna	oceanic bonito	false albacore	wahoo	dolphin	barracuda*	Total
filefishes	9	1	4	-	-	37	1	52
trigger-fishes	12	-	-	-	-	23	-	35
puffers	9	7	-	-	1	8	-	25
porcupine-fish	-	-	-	-	-	3	1	4
trunkfish	3	-	1	-	1	4	-	9
doctorfish	4	2	1	-	1	7	-	15
squirrel-fish	5	1	3	-	-	4	-	13
goatfish	2	2	-	1	-	6	-	9
flyingfish	2	-	4	-	2	61	-	69
frigate mackerel	-	-	1	-	-	-	-	1
snake mackerel	4	-	-	-	1	4	-	9
Pseudosco-pelus	6	-	1	-	3	**	-	10
squids	20	4	2	-	1	15	-	42
crab mega-lops	1	4	6	-	-	-	-	11
Stomatopods	1	-	1	-	-	3	-	5

*Barracudas and painted mackerels generally feed on reef fishes near shore, which fishes are mentioned in Table II.

**The lack of *Pseudoscopelus* in dolphin stomachs may only indicate that the dolphin is primarily a day feeder.

DISCUSSION

CURRENT STATUS OF THE MARLINS AND SPEARFISHES
C. Richard Robins

Erdman:
You mentioned a fish with a vertebral count of 13 + 11. Is this closer to the spearfish group or to the blue marlin?

Robins:
It is closer to the spearfish group which has 12 + 12 vertebrae. Within the group it resembles the spearfish most in that the dorsal profile of the fish in question rises only slightly to the first dorsal fin. The sailfishes and the white marlin are, in contrast, humpbacked. Also the general shape of the dorsal fin is that of a spearfish.

Mowbray:
How do you distinguish caudal from precaudal vertebrae?

Robins:
This is easy in billfishes for the precaudal vertebrae show no transition toward a development of a haemal arch. The first caudal vertebrae has a fully developed arch and spine.

CONTRIBUTION TO THE BIOLOGY OF THE TARPON, MEGALOPS ATLANTICA
John E. Randall

Mowbray:
To what do you attribute the finding of young tarpon in isolated pools?

Randall:
An extensive survey has not been made. We found them on Lower Matecumbe Key and did not look further. They may actually seek out such isolated areas Some are completely landlocked and thus lost to the population. Others may be released at high tides or during storms. The young tend to swim inland.

Mowbray:
Tarpon have been found in completely landlocked areas?

Randall:
Yes.

Mowbray:
The number of young fish found does not account for the large number of tarpon found outside.

Randall:
While we have found most small tarpon in isolated pools it may be that they are more easily collected there.

Mowbray:
Is the proximity to freshwater essential to spawning?

Randall:
I do not believe so. The beaches along Boca Grande and northward to Sarasota are not brackish. This region is one of ordinary Gulf water. I think that tarpon seek out the open sea for spawning. At Boca Grande we sometimes see fish of a bronze hue which the guides say are river fish, but we have no tag returns to substantiate this at present.

Gorham:
Does that mean that you have not caught any small tarpon in salt water?

Randall:
We have not taken any in a strictly marine environment.

Gorham:
I caught a 3/4 oz. tarpon, 3 1/2 inches long well offshore on one occasion.

Clark:
I have heard of hammerhead sharks attacking tarpon. How many of the fish that you tagged were attacked?

Randall:
We lost two to sharks. I took a small capsule of copper acetate and fastened it with tape to the spaghetti tags. We punctured the capsule just as the tarpon was released but the hammerhead did not hesitate.

Bullis:
In early September we were in Dutch Guiana and discussing fish culture. It was said that tarpon larvae invaded the ponds that resulted when farms were flooded, also 15 or 20 tarpon of about 35 lbs. Apparently, this is a common occurrence.

Corlett:
Are tarpon migratory?

Randall:
Walter Starck has reported them throughout the year at Matecumbe Key. The guides say they do not stay at Boca Grande. They believe they move northward and come back via Yucatan and Cuba. One guide predicts the first tags will come in from Port Aransas, Texas (ed. note, one has since been returned from Louisiana). The absence of

tarpon may be only a result of the seasonal nature of fishing effort. Al Pflueger reported tarpon off Alligator Light. Obviously they were going somewhere.

Voss:
At Fort Lauderdale and Palm Beach we have two distinct migrations a year on the inside of the inner reef. These schools may have 5000 - 6000 individuals and they are large fish. They will not strike when running. They go south in the spring and north in the fall.

Gorham:
I will verify that.

ASPECTS OF THE LIFE HISTORY OF THE GREAT BARRACUDA
Donald P. de Sylva
(Randall standing in)

Randall:
Don's paper was given earlier at the meetings at the University of Indiana. It is good to see that someone is doing some original thinking on the subject of fish poisoning, not merely perpetuating the old wives' tales. The poisoning caused by puffer fishes etc. has a different origin and different characteristics than ciguatera. Puffer toxin is produced by the fishes themselves. The ciguatera toxin is acquired. Don mentions dinoflagellates etc. Here again we have distinct toxins. Toxic dinoflagellates have caused toxic clams and mussels, etc. some of which cause severe toxemia in man. But the symptons are distinct from ciguatera. I believe the basic cause of ciguatera is a bottom dwelling blue-green alga which is one of the first organisms to take over new surfaces in the sea. Such new surfaces are caused by wrecks, freshets from streams, rock slides on steep reef areas etc. Such areas are notorious for ciguatera. The toxin is accumulated by larger predatory fishes.

Erdman:
In Costa Rica, in two years, I never heard of fish poisoning and I do not think that there are many cases in the Panama Canal region. The water is dirty in such areas and algae would have a difficult time growing. Perhaps this is the answer.

Mowbray:
What are the symptoms of ciguatera?

Randall:
There is a tingling sensation. There is a gastric disturbance, frequently diarrhea and sometimes weakness. The patient may go into coma and die.

Bullis:
On two occasions during longlining operations I caught barracuda,

hundreds of miles from land and at 30 fathoms. This is unusual for we do not associate barracuda with the open ocean. Possibly, they could have been hooked nearer the surface when the gear was being lowered or raised.

Mowbray:
In Bermuda we find that barracuda do migrate about May. Then again about October they go off. At that time we never catch barracuda off the reef area. It is reasonable that you could get them at 30 fathoms.

MARLIN AND SAIL FISHING ON THE EAST COAST OF SOUTH AFRICA
John K. Howard

General Question:
Will you describe live bait fishing?

Howard:
I have seen live bait fishing in New Zealand and in Australia but not in South Africa. Fishermen do a lot of drifting in both New Zealand and Australia. I mentioned the attitude of the railway administration and the reason why the agency does not allow boats in the harbor. The result was the development of a boat with which they could go in and out of a beach. They drift over bank areas and troll around them. They do not use live bait but fish with a small sardine-like fish and two hooks.

Roman:
You said marlin could be caught on plugs. What kind of plug is used?

Howard:
The Hawaiian plug is used. In almost any area which has not been fished much, marlin and sailfish are usually taken first on feathers and I have seen them caught on a spoon. I think you can get strikes on almost anything. The question is whether you can hook and land a billfish.

Cohn:
Do you have any preference as to size of bait in fishing for marlin?

Howard:
My opinoin is that they will take anything. If you are using bait that may be taken by other fishes, it is better to use larger bait.

Mowbray:
I have a comment on the size of bait. In the Commercial Fisheries Review about two years ago it stated that in Honolulu a large marlin had a complete 85 lb. yellowfin tuna in its stomach.

Howard:
A marlin recently was taken with a 158 lb. tuna in its stomach.

Roman:
Off Bimini a blue marlin was taken that contained 86 porcupine fish 1 inch to 1 1/2 inches long.

A PRELIMINARY REVIEW OF THE AMBERJACKS, GENUS SERIOLA, OF THE WESTERN ATLANTIC

Frank J. Mather III

Gorham:
Is it true that the rear portion of the amberjack is full of worms?

Mather:
I have been told that this is true but have not personally observed this situation. In Bermuda it is a very high grade fish. In other places it is not.

Gorham:
Is the California yellowtail an amberjack?

Mather:
Yes.

Clark:
Will your paper be published?

Mather:
It will be mimeographed with the other papers of this conference. Later I hope to prepare a formal publication.

FOODS OF PELAGIC FISHES FROM PUERTO RICO AND THE BAHAMA ISLANDS

Donald S. Erdman

Mowbray:
Many people who fish can make a contribution to biology by noting when, where and at what depth it was caught and the food items contained in its stomach.

Erdman:
One item I should mention was the finding last spring of a bird, a petrel, in the stomach of a blue marlin.

Bullis:
You say you found many small filefish and triggerfish in the stomach contents. It sounds like they take smaller fish. We find large masses of sargassum weed as well.

Erdman:
They go after the weed rather than after individual fish. One charter boatman noted a group of fish ganging up on pieces of weed.

Bullis:
I watched a small sailfish feeding in a 50 ft. patch of sargassum weed.

Robins:
The stomach contents of some game fishes are our best source of young swordfish in the Miami region.

Hargis:
I wish to enlist the help of persons at this conference. I am interested in receiving flat worms which are found on billfishes and many other large fishes. This study may shed some light on the relationship of the fishes themselves The flat worms should be scraped off, dropped in a saturated solution of chloretone and sea water. Then, after about 1/2 - 1 hour add enough formaldehyde to pickle them (about 5%).

Robins:
We at The Marine Laboratory are privileged to number among our friends the members of the Miami Rod and Reel Club. We pick up much information from Ed Corlett, Al Pflueger and many others. I wish to take this opportunity to thank Mr. Simmons and Mr. Corlett, on behalf of The International Oceanographic Foundation and The Marine Laboratory for being our hosts this afternoon.